TRANSMISSION SYSTEM ENGINEERING

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INTRODUCTION

The Transmission System Engineering (TSE) analysis provides the basis for the findings in the Energy Commission's decision. Through this analysis staff determines whether or not the transmission facilities associated with the proposed project conform to all applicable laws, ordinances, regulations and standards (LORS) required for safe and reliable electric power transmission and whether or not the applicant has accurately identified all interconnection facilities required for addition of the project to the electric grid.

Staff evaluated the power plant switchyard, outlet line, termination and downstream facilities identified by the applicant. Staff's analysis provides proposed conditions of certification to ensure the project complies with applicable LORS during the design review, construction, operation and potential closure of the project.

Additionally, under the California Environmental Quality Act (CEQA), the Energy Commission must conduct an environmental review of the "whole of the action," which may include facilities not licensed by the Energy Commission (California Code of Regulations, title 14, §15378). Therefore, the Energy Commission must identify and evaluate the environmental effect of construction and operation of any new or modified transmission facilities required for the project's interconnection to the electric grid. This includes the facilities beyond the project's interconnection with the existing transmission system that are required as a result of the power plant addition to the California transmission system.

Calpine, doing business as East Altamont Energy Center, LLC (applicant) filed an Application for Certification with the California Energy Commission to construct an 820 megawatt (MW) natural gas-fired combined cycle plant which is proposed to be augmented with 250 MW of duct burning for a total 1,070 MW generating capacity to be located in northeastern Alameda county. The applicant proposes to connect their project, East Altamont Energy Center (EAEC), to the existing Tracy-Westley 230 kV (see Definition of Terms) transmission (EAEC 2001a, AFC pages 1-1 to 1-3, 5-1). The plant could be on-line by the summer of 2005. Unlike other applications for certification, since the Western system is not a part of the California Independent System Operator (Cal-ISO) grid, the Cal-ISO is not directly responsible for ensuring electric system reliability for the generator interconnection and does not provide analysis and testimony in the Commission's process. The staff, therefore, has increased responsibility to evaluate the system reliability impacts of the project and provide conclusions and recommendations to the Commission.

SUMMARY OF CONCLUSIONS

1. The proposed EAEC power plant switchyard, outlet lines, and termination are adequate, in accordance with good utility practices and are acceptable to staff. These facilities would be designed, owned and operated by Western. Either Western or the applicant would build these facilities. If the applicant builds the facilities, the construction would be according to Western design and specifications and as such would be done under the supervision of Western. With implementation of the conditions of certification recommended by staff, these facilities will comply with LORS.
2. The System Impact Studies performed by Western and PG&E reveal that the interconnection of the EAEC project would have some adverse impacts on the transmission system. There would be overload criteria violations in several transmission facilities of the Western, PG&E, SMUD and MID systems under normal and emergency conditions of the electrical grid. However, most of these overload violations are due to aggravation of the already existing pre-project overloads. The mitigation measures proposed will be effective in eliminating the adverse impacts of the project.

LAWS, ORDINANCES, REGULATIONS AND STANDARDS (LORS)

California Public Utilities Commission (CPUC) General Order 95 (GO-95), “Rules for Overhead Electric Line Construction,” formulates uniform requirements for construction of overhead and underground lines. Compliance with these orders ensures adequate service and safety to persons engaged in the construction, maintenance and operation or use of overhead electric lines and to the public in general.

California Public Utilities Commission (CPUC) General Order 128(GO-128), “Rules for Construction of Underground Electric Supply and Communications Systems,” formulates uniform requirements and minimum standards to be used for underground supply systems to ensure adequate service and safety to persons engaged in the construction, maintenance and operation or use of underground electric lines and to the public in general.

Western “General Requirements for Interconnection,” September 1999, provides Western’s general minimum requirements including technical, environmental and contractual requirements for interconnection, additions and modifications to Western’s transmission facilities.

The National Electric Safety Code, 1999 provides electrical, mechanical, civil and structural requirements for overhead electric line construction and operation.

The North American Electric Reliability Council (NERC) and Western Systems Coordinating Council (WSCC) Planning Standards were merged. The combined Planning Standards are now referred to as the NERC/WSCC Planning Standards and provide the system performance standards used in assessing the reliability of the interconnected system. Certain aspects of the NERC/WSCC standards are either more stringent or more specific than the NERC standards. These standards provide guidance for planning electric systems so as to withstand the more probable forced and maintenance outage system contingencies at projected customer demand and anticipated electricity transfer levels, while continuing to operate reliably within equipment and electric system thermal, voltage and stability limits. These standards include the reliability criteria for system adequacy and security, system modeling data requirements, system protection and control, and system restoration. Analysis of the WSCC system is based to a large degree on Section I.A of the standards, “NERC and WSCC Planning Standards with Table I and WSCC Disturbance-Performance Table” and on Section I.D, “NERC and WSCC Standards for Voltage support and Reactive Power.” These standards require that the results of power flow and stability simulations meet defined performance levels. Performance levels are defined by specifying the allowable variations in thermal loading, voltage and frequency, and loss of load that may occur on systems during various disturbances. Performance levels range from no significant adverse effects inside and outside a system area during a minor disturbance (loss of load or a single transmission element out of service) to levels designed to prevent system cascading and the subsequent blackout of islanded areas during a major disturbance (such as loss of multiple 500 kV lines in a right of way and/or multiple generators). While controlled loss of generation or load or system separation is permitted in certain circumstances, their uncontrolled loss is not permitted (WSCC 2001).

NERC Planning Standards provide national policies, standards, principles and guidelines to assure the adequacy and security of the electric transmission system. The NERC planning standards provide for system performance levels under normal and contingency conditions. With regard to power flow and stability simulations, while these Planning Standards are similar to WSCC Standards, certain aspects of the WSCC standards are either more stringent or more specific than the NERC standards for Transmission System Contingency Performance. The NERC planning standards apply not only to interconnected system operation but also to individual service areas (NERC 1998).

Cal-ISO Grid Planning Standards also provide standards, and guidelines to assure the adequacy, security and reliability in the planning of the Cal-ISO transmission grid facilities. The Cal-ISO Grid Planning Standards incorporate the WSCC and NERC Planning Standards. With regard to power flow and stability simulations, these Planning Standards are similar to WSCC and the NERC Planning Standards for Transmission System Contingency Performance. However, the Cal-ISO Standards also provide some additional requirements that are not found in the WSCC or NERC Planning Standards. The Cal-ISO Standards apply to all participating transmission owners interconnecting to the Cal-ISO controlled grid. It also applies when there are any impacts to the Cal-ISO grid due to facilities interconnecting to adjacent controlled grids not operated by the Cal-ISO (Cal-ISO 2002a).

EXISTING FACILITIES AND RELATED SYSTEMS

The existing bulk transmission facilities in the vicinity of the EAEC project area include:

Western’s Tracy 500/230 kV Substation.

Tracy-Westley 230 kV transmission line.

Tracy-Olinda 500 kV transmission line.

Tracy-Tesla 500 kV transmission line.

Tracy-Los Banos 500 kV transmission line.

Tracy-Hurley 230 kV transmission lines #1 & 2.

Tracy-Tesla 230 kV transmission lines #1 & 2.

Tracy-LLNL 230 kV transmission line.

Tesla-Vaca Dixon 500 kV transmission line, and

Tesla-Table Mountain 500 kV transmission line.

The Tracy Substation receives significant power from the California Oregon Transmission project, which is part of the Path 66 500 kV lines that form the California Oregon Interties (COI). These lines carry California hydroelectric generation and imports from the Pacific Northwest. The Tracy substation is also connected to the Los Banos-Gates-Midway Path 15 transmission system. Two 230 kV lines from the Tracy substation are connected to the Sacramento Municipal Utility District (SMUD) system. Additional 230 kV lines are connected to the Pacific Gas & Electric (PG&E), Modesto Irrigation District (MID), and Turlock Irrigation District (TID) systems. The EAEC project would potentially decrease the 500 kV line flows and increase the 230 kV line flows. The 230 kV line flow increases have the potential to cause transmission congestion and overload reliability criteria violations in the area.

PROJECT DESCRIPTION

SWITCHYARD AND INTERCONNECTION FACILITIES

The EAEC site would be located at the northeastern edge of Alameda County, about 8 miles northwest from the city of Tracy, California and about 0.4 miles east of Western's existing Tracy Substation. The EAEC would consist of three combustion turbine generators (each 198.9 MW gross capacity) and one steam turbine generator (569.5 MW gross capacity), for a total nominal output of 1,100 MW. Each generating unit would be connected to a 18/230 kV step-up transformer and the high voltage terminals of the transformers would be connected to a new EAEC 230 kV switchyard bay by overhead conductors. The new EAEC 230 kV switchyard would be configured with a 3,000-ampere main and a 3,000-ampere transfer bus. The switchyard would have four or five switch bays, each with a breaker and a half arrangement, for a total of up to fifteen air-insulated 230 kV circuit breakers. Each breaker would be designed for 63 kiloampere (kA) interrupting capacity. The EAEC switchyard would be connected to the existing Western grid by looping the existing Tracy-Westley double circuit lines (jointly owned by the MID and TID. It is currently operating as a single line, but would be split into two lines) through the EAEC switchyard by terminating the lines on two 2,000 ampere separate breakers at the Tracy and Westley substation ends. In order to connect the EAEC switchyard to the existing Tracy-Westley 230 kV double circuit lines, about 0.5 mile of two new double circuit transmission lines on separate steel tubular pole structures would be built on the south side of the EAEC switchyard. As a result, there would be two Tracy-EAEC 230 kV lines and also two EAEC-Westley 230 kV lines (EAEC 2001a, AFC pages 5-1 to 5-6, figures 5.1-2, 5.2-1 to 5.2-5, 5.5-1 to 5.5-3). This configuration for the interconnection and switchyard is in accordance with good utility practices and is considered acceptable. The EAEC switchyard work would be done within the fenced yard of the EAEC plant. The preferred route for the new interconnection transmission lines would extend from the EAEC plant to Kelso Road.

ANALYSIS AND IMPACTS

SYSTEM RELIABILITY

Introduction

A System Impact Study (SIS) for connecting a new power plant to the existing power system grid is performed to determine the alternate and preferred interconnection facilities to the grid, downstream transmission system impacts and their mitigation measures in conformance with system performance levels as required in utility reliability criteria, NERC planning standards, WSCC reliability criteria and Cal-ISO reliability criteria. The study determines both positive and negative impacts, and for the reliability criteria violation cases (for the negative impacts) determines the alternate and preferred additional transmission facilities or other mitigation measures. The study is conducted with and without the new generation project and its interconnection facilities by using the computer model base case for the year the generator project would come on-line. The study normally includes a Load Flow study, Transient Stability study, Post-transient Load Flow study and Short Circuit study. The study is focused on thermal overloads, voltage deviations, system stability (excessive oscillations in generators and transmission system, and voltage collapse) and short circuit duties. The study must be conducted under the normal condition (N-0) of the system and also for all credible contingency/emergency conditions, which include the loss of a single system element (N-1) such as a transmission line, transformer or a generator and the simultaneous loss of two system elements (N-2), such as two transmission lines or a transmission line and a generator. The study may also be conducted for credible simultaneous loss of multiple (more than two) system elements. In addition to the above analysis, the studies may be performed to verify whether sufficient active or reactive power margins are available in the area system or area sub-system to which the new generator project would be interconnected. The SIS is followed by supplemental studies by the transmission owner with details provided in a Detailed Facility Interconnection Study (DFIS) or a Facility Cost Report (FCR).

Scope of the SIS and DFIS

The SIS was performed by Western, (the transmission owner), and PG&E (EAEC 2001e, Data Adequacy Response Set 1, Attachment TSE-1, SIS) with a 2005 summer peak case, which included approved PG&E and SMUD major transmission expansion plans, modeled major transmission system path flows, major generation in the system, and all proposed generation projects queued to be on-line before the on-line date of the EAEC project. The EAEC net maximum generation output was modeled as 1,070 MW. The Western report included a Power Flow study with and without the EAEC project under normal and contingency conditions, Post-transient Voltage study, and the Short Circuit study for PG&E, Western, SMUD, MID and TID systems. The PG&E report included a Dynamic Stability Analysis and a Short Circuit study with addition of the EAEC project for the PG&E system. Western performed the SIS with a 2005 spring peak case, but did not find any adverse impacts in the system due to the addition of the EAEC (EAEC 2001e, SIS, Attachment TSE-1).

The DFIS was performed by Western subsequent to the SIS with a 2005 summer peak case (EAEC 2002ddd, DFIS). The study report by Western included a Power Flow study under normal conditions and additional contingency conditions in the Western and SMUD systems, a Dynamic Stability analysis under additional contingencies in the Western and SMUD systems, a post-transient Load Flow study and a Short Circuit analysis.

Power Flow Study Results

Based on the SIS and DFIS results, there are some adverse impacts on the electrical grid due to interconnection of the EAEC as proposed. The results indicate that there would be overload criteria violations due to the project impact under normal (N-0) and emergency contingency (N-1 & N-2) conditions of the network in Western, SMUD, MID and PG&E systems.

Normal (N-0) Conditions and Mitigation

Under normal conditions of the network with all facilities in service in the 2005 summer peak case scenario, the study identifies that the project would cause one new thermal overload on the existing Tracy-Westley 230 kV Line #1 or the proposed EAEC-Westley 230 kV Line #1. The project would also aggravate several pre-project existing normal base case overloads on the transmission facilities as summarized in Table 1 below with respective selected mitigation measure(s) (EAEC 2001e, SIS; EAEC 2002ddd, DFIS, PG&E letters, SMUD letter, EAEC letter):

Table 1
2005 Summer Peak N-0 Overloads and Mitigation

Overloaded Facility	Percentage Loading of the Facility		Percentage Increment in Loading	SELECTED MITIGATION
	Pre-EAEC	Post-EAEC		
1. EAEC-Westly 230 kV Line #1	59.4	115.45	56.05	Western Project: Splitting the existing double circuit single 230 kV Line between Tracy and Westley into two separate 230 kV Lines, and Looping the two 230 kV Lines in and out of the proposed new EAEC Switchyard.
2. Brighton 230/115 kV Transformer Bank	188.0	190.40	2.4	PG&E Project T-758: Installing a second 230/115 kV transformer bank at Brighton in 2004 and/or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.

Overloaded Facility	Percentage Loading of the Facility		Percentage Increment in Loading	SELECTED MITIGATION
	Pre-EAEC	Post-EAEC		
3. Los Banos 230/70 kV Transformer bank	123.53	126.23	2.7	PG&E Project T-710: Installing an additional 230/70 kV transformer bank at Los Banos substation by June 2005 and/or congestion management, returning the loading to pre-EAEC level, by curtailing EAEC generation.
4. Pittsburg-Tassajara 230 kV Line	100.3	102.78	2.48	PG&E Project T-665: Reconductor the Pittsburg-Tassajara 230 kV Line by June 2002 and/or congestion management returning loading to pre-EAEC level, by curtailing EAEC generation.
5. Cotra Costa-Las Positas 230 kV Line	100.4	102.4	2.0	PG&E Project T-772: Reconductor the Cotra Costa-Las Positas 230 kV Line by June 2002 and/or congestion management returning loading to pre-EAEC level, by curtailing EAEC generation.
6. New calt-Flint 115 kV Line	122.8	123.8	1.0	PG&E Project T-444: Installing SCADA system in the area and re-rating Gold Hill-Placer #1 and #2 115 kV lines (the target line is a tap section off the #2 line) to 3 feet per second wind speed rating by June, 2002 and/or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.
7. Horshalt-Newcalt 115 kV Line	122.7	123.7	1.0	PG&E Project: T-444: Installing SCADA system in the area and Re-rating Gold Hill-Placer #1 and #2 115 kV lines (the target line is a tap section off the #2 line) to 3 feet per second wind speed rating by June 2002 and/or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.
8. Panoche 230/115 kV Transformer Bank #1	137.09	138.08	0.99	PG&E status: Overloads no longer exist in the transformer bank due to several generation projects placed on-line in the Panoche 115 kV system.
9. Panoche-Panoche 2M 230 kV Line or Panoche 230/115 kV Transformer Bank #2	138.27	139.19	0.92	PG&E status: Overloads no longer exist in the transformer bank due to several generation projects placed on-line in the Panoche 115 kV system.

Overloaded Facility	Percentage Loading of the Facility		Percentage Increment in Loading	SELECTED MITIGATION
	Pre-EAEC	Post-EAEC		
10. Proctor-Hedge 230 kV Line	**129.09**	**146.65**	**17.56**	**SMUD Project: Reconductor the Proctor-Hedge 230 kV Line if Rio Linda/Elverta Generation Project comes on-line before EAEC. Otherwise operating procedures by curtailing EAEC generation to eliminate any potential overload caused by EAEC (see Comments on Mitigation Measures).**
11. Elverta S- Natoma S 230 kV LIne	**106.28**	**115.8**	**9.52**	**SMUD Project: Reconductor the Elverta S- Natoma S 230 kV Line if Rio Linda/Elverta Generation Project comes on-line before EAEC. Otherwise no action needed by EAEC.**

Contingency (N-1/Cal-ISO Category B) Conditions and Mitigation

Under single (N-1) or Cal-ISO Category B contingency conditions, the study identifies that the project would cause one new emergency overload on the existing Tracy-Westley 230 kV Line #1 or the proposed EAEC-Westley 230 kV Line#1. In addition the project would violate overload planning criteria by increasing pre-project existing N-1/Category B emergency overloads on the following transmission facilities as summarized in Table 2 below with respective mitigation measure(s) (EAEC 2001e, SIS; EAEC 2002ddd, DFIS, PG&E letters, SMUD letter, EAEC letter):

Table 2:
2005 Summer Peak N-1/Category B Emergency Overloads and Mitigation

Overloaded Facility	N-1 or Category B Contingency	Percentage Loading of the Facility		Percentage increment in Loading	SELECTED MITIGATION
		Pre-EAEC	Post-EAEC		
1. EAEC-Westley 230 kV Line#1	**Overloaded for 8 contingencies, most severe contingency: Tracy- Hurley # 1 or 2 230 kV LIne**	**63.7**	**120.33**	**56.63**	**Western Project: Splitting the existing double circuit single 230 kV Line between Tracy and Westley into two separate 230 kV Lines, and Looping the two 230 kV Lines in and out of the proposed new EAEC Switchyard.**
2. Pittsburg-Tassajara 230 kV Line	**Pittsburg-East Shore 230 kV line**	**100.15**	**102.34**	**2.19**	**PG&E Project T-665: Reconductor the Pittsburg-Tassajara 230 kV Line by June 2002 and/or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.**
3. Pittsburg-East Shore 230 kV Line	**Overloaded for 2 contingencies. Severe Contingency: Pittsburg-San Mateo 230 kV Line**	**107.66**	**109.68**	**2.02**	**PG&E Project T-768: Installing 10 ohm reactors on Pittsburg-San Mateo and Pittsburg-East Shore 230 kV Lines by April 2002 and/or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.**

Overloaded Facility	N-1 or Category B Contingency	Percentage Loading of the Facility		Percentage increment in Loading	SELECTED MITIGATION
		Pre-EAEC	Post-EAEC		
4. Pittsburg- San Mateo 230 kV line	Pittsburg-East Shore 230 kV line	103.08	104.98	1.9	PG&E Project T-768: Installing 10 ohm reactors on Pittsburg-San Mateo and Pittsburg-East Shore 230 kV Lines by April 2002 and/or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.
5. Palermo 230/115/60 kV transformer Bank	Overloaded for 7 contingencies, most severe contingency: Vaca-Dixon 500/230 kV transformer Bank	102.35	109.24	6.89	PG&E Project T-686: Installing an additional Palermo 230/115 kV transformer Bank or Replace the existing Palermo transformer Bank or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.
6. Panoche-Panoche 2M 230 kV Line or Panoche 230/115 kV Transformer Bank #2	New Melones-Wilson 230 kV line	131.76	134.65	2.89	PG&E status: Overloads no longer exist in the transformer bank due to several generation projects placed on-line in the Panoche 115 kV system.
7. Brighton 230/115 kV transformer Bank	Woodland-Davis 115 kV Line and Woodland Generation	184.91	186.21	1.3	PG&E Project T-758: Installing a second 230/115 kV transformer bank at Brighton in 2004 and/or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.
8. Los Banos 230/70 kV transformer Bank	New Melones-Wilson 230 kV line	111.86	115.09	3.15	PG&E Project T-710: Installing an additional 230/70 kV transformer bank at Los Banos substation by June 2005 and/or congestion management, returning the loading to pre-EAEC level, by curtailing EAEC generation.
9. Proctor-Hedge 230 kV Line	Overloaded for 16 contingencies, most severe contingency: Cottonwood-Roseville 230 kV Line	101.24	117.54	16.3	SMUD Project: Reconductor the Proctor-Hedge 230 kV Line if Rio Linda/Elverta Generation Project comes on-line before EAEC. Otherwise operating procedures by curtailing EAEC generation to eliminate any potential overload caused by EAEC (see Comments on Mitigation Measures).
10. Elverta S-Natoma S 230 kV Line	Overloaded for 15 contingencies, most severe contingency: Elverta-Hurley #1 230 kV Line	112.13	123.16	11.03	SMUD Project: Reconductor the Elverta S- Natoma S 230 kV Line if Rio Linda/Elverta Generation Project comes on-line before EAEC. Otherwise no action needed by EAEC.
11. Parker MID 230/69 kV transformer Bank # 1 or #2	Parker MID-Parker 2M 230 kV Line or Parker MID-Parker 1 M 230 kV Line	109.7	113.16	3.46	MID project: Installing a third Parker MID 230/69 kV transformer Bank

Contingency (N-2/Cal-ISO Category C) Conditions and Mitigation

Under single (N-2) or Cal-ISO Category C contingency conditions, the study identifies that the project would cause one new emergency overload on the existing Tracy-Westley 230 kV Line or the proposed EAEC-Westley 230 kV Line #1. The project would also violate overload planning criteria by aggravating pre-project existing emergency overloads on the following transmission facilities as summarized in the Table 3 below with respective selected mitigation measure(s) (EAEC 2001e, SIS; EAEC 2002ddd, DFIS, PG&E letters, SMUD letter, EAEC letter):

Table 3
2005 Summer Peak N-2/Category C Emergency Overloads and Mitigation

Overloaded Facility	N-2/Category C Contingency	Percentage Loading of the Facility		Percentage Increment in Loading	SELECTED MITIGATION
		Pre-EAEC	Post-EAEC		
1. EAEC-Westley 230 kV Line#1	Overloaded for 10 contingencies, most severe contingency: Tracy-Hurley 230 kV Lines #1 &2	68.7	128.3	59.6	Western Project: Splitting the existing double circuit single 230 kV Line between Tracy and Westley into two separate 230 kV Lines, and Looping the two 230 kV Lines in and out of the proposed new EAEC Switchyard.
2. Capehorn-Rollins 60 kV Line (A tap section of Drum-Grass valley-Weimar 60 kV Line)	Overloaded for 2 contingencies, most severe contingency: Tracy 230 kV West Bus section	113.8	115.4	1.6	PG&E Operation Arrangement: Overload eliminated by opening Weimar Switch #79.
3. Panoche-Panoche 2M 230 kV Line or Panoche 230/115 kV transformer Bank #2	Overloaded for 4 contingencies, most severe contingency: Tracy 230 kV East Bus section	138.9	140.9	2.0	PG&E status: Overloads no longer exist in the transformer due to several generation projects placed on-line in the Panoche 115 kV system.
4. Panoche 230/115 kV transformer Bank #1	Overloaded for 5 contingencies, most severe contingency: Tracy 230 kV East Bus section	137.7	139.8	2.1	PG&E status: Overloads no longer exist in the transformer due to several generation projects placed on-line in the Panoche 115 kV system.
5. Bonnie N-Drum 60 kV Line	Overloaded for 2 contingencies, most severe contingency: Tracy-Tesla and Tracy- Los Banos 500 kV Lines	113.01	115.33	2.32	PG&E Operation Arrangement: Overload eliminated by opening Weimar Switch #79.
6. Bonnie N-Capehorn 60 kV Line	Overloaded for 2 contingencies, most severe contingency: Tracy-Tesla and Tracy- Los Banos 500 kV Lines	107.83	110.11	2.28	PG&E Operation Arrangement: Overload eliminated by opening Weimar Switch #79.

Overloaded Facility	N-2/Category C Contingency	Percentage Loading of the Facility		Percentage Increment in Loading	SELECTED MITIGATION
		Pre-EAEC	Post-EAEC		
7. Proctor-Hedge 230 kV Line	**Overloaded for 9 contingencies, most severe contingency: Tracy-Tesla and Tracy- Los Banos 500 kV Lines**	**118.06**	**126.56**	**8.51**	**SMUD Project: Reconductor the Proctor-Hedge 230 kV Line if Rio Linda/Elverta Generation Project comes on-line before EAEC. Otherwise operating procedures by curtailing EAEC generation to eliminate any potential overload caused by EAEC (see Comments on Mitigation Measures).**
8. Los Banos 230/70 kV transformer Bank	**Overloaded for 3 contingencies, most severe contingency: Tracy 230 kV East bus section**	**122.1**	**127.4**	**5.3**	**PG&E Project T-710: Installing an additional 230/70 kV transformer bank at Los Banos substation by June 2005 and/or congestion, management returning the loading to pre-EAEC level, by curtailing EAEC generation.**
9. Contra Costa-Las Positas 230 kV Line	**Overloaded for 2 contingencies, most severe contingency: Morago 230 kV bus section**	**104.11**	**106.64**	**2.53**	**PG&E Project T-772: Reconductor the Contra Costa-Las Positas 230 Line by June 2002 and/or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.**
10. Pittsburg-Tassajara 230 kV Line	**Overloaded for 3 contingencies, most severe contingency: East Shore 230 kV bus section**	**100.66**	**102.86**	**2.2**	**PG&E Project T-665: Reconductor the Pittsburg-Tassajara 230 kV Line by June, 2002 and/or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.**
11. Brighton 230/115 kV transformer Bank	**Tracy 230 kV East Bus section**	**192.4**	**195.6**	**3.2**	**PG&E Project T-758: Installing a second 230/115 kV transformer bank at Brighton in 2004 and/or congestion management, returning loading to pre-EAEC level, by curtailing EAEC generation.**

Comments on Mitigation Measures

The existing 230 kV line between the Tracy and Westley substations, owned by the MID & TID, was built as a double circuit line on the same transmission structures and is now operating as a single line. The studies find that with interconnection of the EAEC plant as proposed, under normal conditions of the network and under several credible single (N-1) and double (N-2) contingency conditions in the Western, SMUD and PG&E systems, the Tracy-Westley 230 kV line would be loaded up to about 128 percent of its emergency rating with the present single line configuration (EAEC 2001e, SIS). Staff, therefore, concurs with Western that to accommodate the EAEC project it would be essential to split the double circuit line into two separate lines by terminating the lines on separate breakers at both ends as proposed. As a result, since the two 230 kV lines would loop in and out of the EAEC switchyard, there would be two Tracy-EAEC and two EAEC-Westley 230 kV lines with a normal capacity of 650 megavolt ampere (MVA) for each line. Staff concurs that splitting the Tracy-Westley 230 kV line would resolve the system impact concerns expressed by MID (MID 2001a).

The existing Tracy 230 kV substation is currently configured as a Main and a Transfer Bus with a single breaker system. The Western report in the DFIS proposes to convert the Tracy 230 kV substation to a Double Bus and a Double Breaker configuration which would increase the operational reliability of the substation on its own as well as in the context of the EAEC interconnection (EAEC 2002ddd, DFIS). Western requires a Double Bus and Double Breaker configuration to split the single system into a double system with required operational and maintenance flexibility to maintain the operational reliability of the substation. Staff concurs that such arrangement is according to good utility practice and would enhance system reliability.

The SMUD projects for reconductoring the Proctor-Hedge and Elverta S-Natoma S 230 kV lines as stated in Tables 1, 2 and 3, are warranted due to the interconnection impact of the proposed Rio Linda/Elverta power project of Florida Power & Light, which is ahead of EAEC in the generation interconnection queue. The EAEC project causes incremental overloads on these two lines on top of pre-project normal and emergency overloads. At this stage because the Rio Linda/Eleverta power project has been withdrawn from the licensing process it is highly unlikely that the Rio Linda/Elverta power project would materialize before the on-line date of EAEC. With the system modeled without the Rio Linda/Elverta power project, the EAEC causes a new slight overload in the Proctor-Hedge 230 kV line and does not cause any overload in the Elverta S-Natoma S 230 kV line. SMUD and the applicant have, therefore signed a letter agreement (EAEC 2002ddd, SMUD letter, EAEC letter) that, in the event the Rio Linda/Elverta power project does not materialize before the on-line date of EAEC, and the Proctor-Hedge and Elverta S-Natoma S 230 kV lines are not reconductored, then initially the EAEC owner and SMUD would work together in good faith to develop and implement appropriate operating procedures to mitigate any potential overloads on the Proctor-Hedge 230 kV line caused by the operation of the EAEC. However, if SMUD and EAEC could not come to an agreement satisfactory to SMUD on the development and implementation of operating procedures, the EAEC owner would be obligated along with any third party generation project developer to fund the transmission upgrades to SMUD's Proctor-Hedge 230 kV line up to a certain amount. Staff concurs with this mitigation arrangement.

The overloads on the PG&E transmission facilities as stated in Tables 1, 2 and 3 above, which comprise incremental overloads due to the EAEC project impact on top of substantial pre-project existing overloads, would be mitigated by the respective PG&E projects as mentioned in the Tables above (EAEC 2002ddd, PG&E letters). PG&E and the Cal-ISO have approved some of the PG&E projects and some are awaiting approval. The projects may be implemented in time for the EAEC on line date or deferred or cancelled. The PG&E letters of December 19, 2001 and April 15, 2002 (EAEC 2002ddd) state that since there is no guarantee that the mitigation project(s) would be approved and materialize, and would be operational in time for the 2005 on-line date of EAEC, the applicant may assume the cost of advancing the PG&E project(s) to coincide with the on-line date of EAEC. Alternately, if the applicant chooses to wait for PG&E to implement the project(s), EAEC would be solely responsible for transmission congestion management at their cost for returning the loading of the facility(s) to pre-EAEC level(s) by curtailing EAEC generation. While staff concurs with the alternate mitigation options as provided in the aforesaid PG&E letters, such arrangement of mitigation measures for the PG&E overloaded facilities is required to be accepted and confirmed by the applicant.

The MID mitigation project, which would consist of installing a third Parker MID 230/69 kV transformer bank would, mitigate overloading of the existing Parker MID transformer banks under contingency conditions. Staff finds this mitigation feasible.

Transient Stability Study Results

Dynamic stability studies were conducted by PG&E as part of the SIS using a 2005 summer peak case to determine if the EAEC would create any adverse impact on the stable operation of the transmission grid following selected Cal-ISO category B (N-1) & C (N-2) outages in the PG&E system (EAEC 2001e, Data Adequacy Response set 1, Attachment TSE-1, PG&E SIS pages 1-5, Appendices A & B). In the DFIS report (EAEC 2002ddd, DFIS), which is supplemental to the SIS, Western provided additional Dynamic Stability study results following credible N-1 and N-2 contingencies in the Western and SMUD systems

The SIS and DFIS results indicate that for integration of the EAEC project, there are no identified transient stability concerns on the transmission system following the selected disturbances.

Short Circuit Study Results and Mitigation

The short circuit study performed by PG&E with a 2005 case evaluated the impact of the EAEC project on the fault duties within PG&E facilities (EAEC 2001e, Data Adequacy Response Set #1, Attachment TSE-1, PG&E SIS Page 7). The 2005 case included all future system additions including all new generation projects up to year 2005. The study indicates that 230 kV breakers at the Tesla substation are currently subject to overstress even without the integration of the EAEC project. PG&E has existing plans (PG&E T-558 project for Tesla transformer bank #6) to upgrade these breakers to 63 kA interrupting capacity. With addition of the EAEC project, the fault duties at Tesla 230 kV buses may exceed 63 kA by about 3.8 percent. Unless the overstressing exceeds 10 percent, PG&E guidelines do not require any upgrading of breakers or mitigation measures. Staff considers this acceptable.

The short circuit study performed by Western (EAEC 2001e, Data Adequacy Response set1, Attachment TSE-1 page 9) with a 2005 case evaluated the impact of the EAEC project on the fault duties within the Western, SMUD, MID & TID facilities. The study results indicate that integration of the EAEC project would not overstress any equipment at the selected substations.

NEW TRANSMISSION LINE AND SYSTEM MODIFICATIONS

Besides the interconnection facilities and switchyard as proposed by the applicant (discussed above), accommodating the power output of the EAEC would not require any new transmission facility.

System modifications proposed by Western include splitting the existing Tracy-Westley 230 kV double circuit line, now operating as a single line, into two separate lines by terminating the lines on separate breakers at both ends. Also included is the MID project for installing a third Parker MID 230/69 kV transformer bank. The PG&E and SMUD projects are required for system reliability and it is preferred that these be implemented before the on-line date of the EAEC; however, EAEC has the option to participate in transmission congestion management by curtailing EAEC generation at their cost if the PG&E and SMUD projects are not built in time.

CUMULATIVE IMPACTS

The SIS and DFIS results show that multiple planned generation projects in the area including the EAEC project have incremental overload system impacts and also show direct impacts due to the EAEC. Considering that the location of the project is very close to the 500/230 kV Tracy substation or functionally at the Tracy substation, which is strongly interconnected through several 230 kV and 500 kV bulk power lines with the rest of northern California transmission system, staff believes that the project would have some cumulative impacts in the interconnected transmission system. The cumulative impacts due to the EAEC, as identified in the SIS and DFIS, would be mitigated.

ALTERNATIVE TRANSMISSION LINE ROUTES

Four Transmission interconnection alternatives (EAEC 2001a, AFC Section 5.3 Pages 5-6 to 5-9) were considered by the applicant as follows:

1. A double circuit 230 kV overhead transmission line from the EAEC 230 kV switchyard to the Tracy 230 kV substation bus with modifications.

2. Two new double circuit overhead transmission lines from the 230 kV EAEC switchyard to loop the existing two single circuit Tracy-Hurley 230 kV lines through the EAEC switchyard.

3. Two new double circuit overhead transmission lines from the 230 kV EAEC switchyard, one to loop into the Tracy-Westley 230 kV line and the other to loop into the eastern circuit of the Tracy-Tesla 230 kV double circuit line.

4. A new double circuit 500kV line from the EAEC 500 kV switchyard to interconnect with the existing Tracy-Tesla and Tracy-Los Banos 500 kV lines, or to the existing Tracy-Olinda 500 kV line.

These interconnection alternatives, when compared to the preferred one (looping the Tracy-Westley 230 kV double circuit line through the EAEC 230 kV switchyard and splitting it into two lines with one additional breaker arrangement at Tracy and Westley 230 kV substations), were not chosen by the applicant on the basis of environmental impacts, engineering feasibility, reliability, longer routes, right-of-way issues, increased costs, contractual issues and visual concerns. The preferred alternative is acceptable to the staff.

COMPLIANCE WITH LORS

The SIS and DFIS comply with NERC/WSCC, NERC and Cal-ISO planning standards and reliability criteria. All the overload criteria violations due to interconnection of the EAEC project would be mitigated effectively. The proposed EAEC switchyard would be located within the fenced yard of the EAEC plant and the overhead 230 kV interconnecting loop lines would extend from the plant to Kelso Road. Staff concludes that all facilities are acceptable and would comply with LORS assuming the Conditions of Certification are met.

Since Western would design, own and operate the EAEC power plant switchyard and outlet lines, and since either Western or the applicant under the supervision of Western would build the facilities, the recommended Conditions of Certification are not the same as those typically recommended by staff for facilities owned by a private developer. Western's role as a federal agency under the United States Department of Energy is to market and transmit electricity through high voltage transmission lines primarily from multi-user water projects. Western has the special expertise and experience to conform to industry standards and regulations.

By voluntarily agreeing to a joint analysis process with the Energy Commission and to any Conditions of Certification imposed by the Energy Commission for approval of the project, Western is not ceding any jurisdictional authority over federal facilities to the State of California.

FACILITY CLOSURE

PLANNED CLOSURE

This type of closure occurs in a planned and orderly manner such as at the end of the power plant's useful economic or mechanical life or due to gradual obsolescence. Under such circumstances, the owner is required to provide a closure plan 12 months prior to closure, which in conjunction with applicable LORS is considered sufficient to provide adequately for safety and reliability. For instance, a planned closure provides time for the owner to coordinate with the Transmission Owner (TO), in this case Western, to assure (as one example) that the TO's system would not be closed into the outlet thus energizing the project substation. Alternatively, the owner may coordinate with the TO to maintain some power service via the outlet line to supply critical station service equipment or other loads.[1]

UNEXPECTED TEMPORARY CLOSURE

An unplanned closure occurs when the facility is closed suddenly and/or unexpectedly for a short term due to unforeseen circumstances such as a natural or other disaster or emergency. During such a closure the facility cannot insert power into the utility system. Closures of this sort can be accommodated by establishing an on-site contingency plan (see **General Conditions Including Compliance Monitoring and Closure Plan**).

[1] These are mere examples, many more exist.

UNEXPECTED PERMANENT CLOSURE

This unplanned closure occurs when the project owner abandons the facility. This is considered to be a permanent closure. This includes unexpected closure where the owner remains accountable for implementing the on-site contingency plan. It can also include unexpected closure where the project owner is unable to implement the contingency plan, and the project is essentially abandoned. An on-site contingency plan, that is in place and approved by the Energy Commission's Compliance Project Manager (CPM) prior to the beginning of commercial operation of the facilities, would be developed to assure safety and reliability (see **General Conditions Including Compliance Monitoring and Closure Plan**).

RESPONSE TO AGENCY COMMENTS

DEPARTMENT OF WATER RESOURCES

On May 14, 2001, the California Department of Water Resources (DWR) submitted a letter regarding the potential effects of increased fault currents due to the addition of EAEC project on the electrical equipment at Banks Pumping and Gianelli Pumped-storage plants (DWR 2001a). In response, the applicant submitted a short circuit study to DWR (EAEC 2001m). The study results indicated that the marginal increases in fault currents would not overstress any electrical equipment at the DWR plants. Staff concurs with the study results.

MODESTO IRRIGATION DISTRICT

MID submitted comments (MID 2001a) to staff regarding the EAEC project interconnection to the Tracy-Westley 230 kV line (line owned by MID & TID and the electrical grid operated by Western). MID had three concerns. The first concern is for any adverse reliability impact in the Tracy-Westley line due to the EAEC project interconnection, and the others are for cost sharing of the relevant transmission project and future ownership of the proposed Tracy-EAEC 230 kV lines along with the proposed interconnection transmission facilities. Staff believes that splitting the Tracy-Westley 230 kV existing double circuit line, now operating as a single line, into two separate lines by terminating the lines on separate breakers at both ends and looping both the lines in and out of the proposed EAEC switchyard would be essential for the EAEC project interconnection, and such transmission arrangement would resolve the system impact concern expressed by MID. With respect to MID concerns regarding the project cost sharing and future ownership of the proposed Tracy-EAEC segment of the transmission lines and the proposed interconnection transmission lines, staff concludes that the applicant would have to coordinate the matter with the concerned parties.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Staff concludes as follows:

The EAEC SIS and DFIS was conducted for a 2005 summer peak case and included approved PG&E and SMUD major transmission expansion plans, modeled major transmission system path flows, included major generation in the system and proposed generation projects in the queue to be on line before the EAEC project. The Rio Linda/Elverta power plant, which was initially ahead of EAEC in the generation queue, was recently withdrawn from the siting process. However, this does not change staff's substantive conclusions because as discussed previously, mitigation for this eventuality has been identified and preliminarily agreed to by SMUD and the EAEC applicant.

Upon review of the SIS/DFIS, staff finds that the EAEC would have some adverse impacts on the transmission system. There would be overload criteria violations in several transmission facilities for interconnection of the EAEC plant under normal and emergency conditions of the electrical grid. The Western, PG&E, SMUD and MID projects identified in Tables 1, 2, and 3 and/or mitigation alternatives like transmission congestion management as selected by the transmission owners to eliminate the overload violations, are considered effective, are according to modern good utility practices, and are acceptable to staff. The applicant, however, needs to confirm their acceptance of the mitigation alternative for each criteria violation as selected by the respective transmission owner (see Conditions of Certification, TSE-1h). iv)).

The EAEC switchyard and interconnection facilities to the Western grid, by looping the Tracy-Westley 230 kV line through the EAEC switchyard, would be adequate and reliable. To accommodate interconnection of the EAEC project and to offset downstream adverse impacts on the transmission system, it would be essential to split the exiting Tracy-Westley 230 kV double circuit line, now operating as a single line, into two separate lines by terminating the lines on two separate breakers at the Tracy and Westley substations. As a result, since the two 230 kV lines would loop in and out of the EAEC 230 kV switchyard, there would be two Tracy-EAEC and two EAEC-Westley 230 kV lines. This arrangement would also resolve the system impact concerns of MID.

The power plant switchyard, outlet lines, and termination are in accordance with good utility practices and are acceptable. These facilities would be designed, owned and operated by Western. Either Western or the applicant would build these facilities. If the applicant builds the facilities, the construction would be according to Western design and specifications, and as such would be done under the supervision of Western. With implementation of the conditions of certification recommended by staff, these facilities would comply with LORS.

RECOMMENDATIONS

If the Commission approves the project, staff recommends the following Conditions of Certification to ensure system reliability and conformance with LORS.

CONDITIONS OF CERTIFICATION FOR TSE

TSE-1 The project owner shall ensure that the design, construction and operation of the proposed transmission facilities shall conform to all applicable LORS including the requirements 1a) through 1h) listed below. The substitution of Compliance project manager (CPM) approved "equivalent" equipment and an equivalent substation configuration is acceptable.

a) The project 230 kV switchyard shall have switch bays with a double bus, and a breaker and a half configuration.

b) The power plant switchyard and outlet lines shall meet or exceed the electrical, mechanical, civil and structural requirements of Western interconnection standards, Western' DFIS, CPUC General Orders 95 (GO-95) or National Electric Safety Code (NESC), Title 8 of the California Code and Regulations, Articles 35, 36 and 37 of the "High Voltage Electric Safety Orders", National Electric Code (NEC) and related industry standards.

c) Breakers and buses in the power plant switchyard and other switchyards, where applicable, shall be sized to comply with a short-circuit analysis.

d) Outlet line crossings and line parallels with transmission and distribution facilities shall be coordinated with the transmission line owner and comply with the owner's standards.

e) Termination facilities shall comply with applicable Western interconnection standards.

f) The project conductors shall be sized to accommodate the full output from the project.

g) The existing Tracy-Westley 230 kV double circuit line shall be split into two lines and terminated on two separate breakers at the Tracy and Westley substations with interconnection of the EAEC plant switchyard to the two lines. The existing Tracy 230 kV bays 1 to 12 shall be converted from main and transfer to a double bus-double breaker configuation.

h) The project owner shall provide:

   i) Any modified Detailed Facility Interconnection Study (DFIS) including a description of facility upgrades, operational mitigation measures, and/or Remedial Action Scheme (RAS) or Special Protection System (SPS) sequencing and timing if applicable,

   ii) Executed Facility Interconnection Agreement with Western,

   iii) A copy of the Notice to Cal-ISO prior to synchronization of the facility with the California transmission grid.

iv) A letter stating that the mitigation measures or projects for each criteria violation selected by Western, PG&E, SMUD and MID are acceptable.

<u>Verification:</u> At least 60 days prior to the start of grading of the power plant switchyard or transmission facilities, the project owner shall submit to the CPM for approval:

Electrical one line diagrams signed and sealed by a registered professional electrical engineer in responsible charge (or other approval acceptable to the CPM), a route map, and an engineering description of equipment and the configurations covered by the requirements 1a) through 1h) above.

The Detailed Facilities Study (if modified) including a description of facility upgrades, operational mitigation measures and/or RAS or SPS, and the Interconnection Agreement (if either one are not otherwise provided to the Commission previously) and a signed letter from the project owner stating that the mitigation measures selected by Western, PG&E, SMUD and MID are acceptable. Substitution of equipment and substation configurations shall be identified and justified by the project owner for CPM approval.

TSE-2 The project owner shall inform the CPM of any impending changes that may not conform to the requirements 1a) through 1h) of **TSE-1**, and have not received CPM approval, and request approval to implement such changes. A detailed description of the proposed change and complete engineering, environmental, and economic rationale for the change shall accompany the request. Construction involving changed equipment or substation configurations shall not begin without prior written approval of the changes by the CPM.

<u>Verification:</u> At least 60 days prior to the construction of the power plant switchyard and transmission facilities, the project owner shall inform the CPM of any impending changes that may not conform to requirements 1a) through 1h) of **TSE-1** and request approval to implement such changes.

TSE-3 The project owner shall be responsible for the inspection of the transmission facilities during project construction, and any subsequent CPM approved changes thereto, to ensure conformance with CPUC GO-95 or NESC, Title 8 of the California Code of Regulations, Articles 35, 36 and 37 of the “High Voltage Electric Safety Orders”, Western’s interconnection standards, NEC, related industry standards and these conditions. In case of non-conformance, the project owner shall inform the CPM in writing, within 10 days of discovering such non-conformance and describe the corrective actions to be taken.

<u>Verification:</u> Within 60 days after first synchronization of the project to the grid, the project owner shall transmit to the CPM an engineering description(s) and one-line diagrams of the “as built” facilities signed and sealed by the registered electrical engineer in responsible charge (or other verification acceptable to the CPM, such as a letter stating that the attached diagrams have been verified by the engineer). A statement attesting to conformance with CPUC GO-95 or NESC, Title 8 of the California Code of Regulations, Articles 35, 36 and 37 of the “High Voltage Electric Safety Orders”, Western’s interconnection standards, NEC, related industry standards and these conditions.

REFERENCES

Cal-ISO (California Independent System Operator) 1998a. Cal-ISO Tariff Scheduling Protocol posted April 1998, Amendments 1,4,5,6, and 7 incorporated.

Cal-ISO (California Independent System Operator) 1998b. Cal-ISO Dispatch Protocol posted April 1998.

Cal-ISO (California Independent System Operator) 2002a. Cal-ISO Grid Planning Standards, February 2002.

CEC (California Energy Commission) 2001a. First Set of Data Requests. Dated and docketed May 10, 2001.

DWR (Department of Water Resources) 2001a. Letter from DWR to CEC with copy to EAEC about potential increase in fault currents at the DWR plants, dated May 14, 2001 and docketed on May 18, 2001.

EAEC (East Altamont Energy Center, LLC) 2001a. Application for Certification, Volume 1 & Appendices, East Altamont Energy Center (01-AFC-4). Dated March 20, 2001. Submitted to the California Energy Commission, March 29, 2001.

EAEC (East Altamont Energy Center, LLC) 2001e. Application for Certification, Data Adequacy Response set 1, East Altamont Energy Center (01-AFC-4), Attachment TSE-1 & PG&E SIS. Dated April 18, 2001. Submitted to the California Energy Commission, May 1, 2001.

EAEC (East Altamont Energy Center, LLC) 2001m. Letter from EAEC to DWR with copy to CEC about potential effects of increased fault currents at the DWR plants, dated July 20, 2001 and docketed on July 25, 2001.

EAEC (East Altamont Energy Center, LLC) 2002ddd. Response to Data Requests set 6, East Altamont Energy Center (01-AFC-4), The Detailed Facility Study Report from Western, PG&E letter of December 19, 2001 and SMUD letter of April 11, 2002, EAEC letter of May 24 2002. Submitted to the California Energy Commission on April 23, 2002

MID (Modesto Irrigation District) 2001a. Comments regarding EAEC’s interconnection to the Tracy-Westley 230 kV line. Dated July 23, 2001 and submitted to the California Energy Commission on July 24, 2001.

NERC (North American Electric Reliability Council) 1998. NERC Planning Standards, September 1997.

WSCC (Western Systems Coordinating Council) 2001. NERC/WSCC Planning Standards, June 2001.

DEFINITION OF TERMS

ACSR	Aluminum cable steel reinforced.
AASS	Aluminum cable steel supported.
AAC	All Aluminum conductor.
Ampacity	Current-carrying capacity, expressed in amperes, of a conductor at specified ambient conditions, at which damage to the conductor is nonexistent or deemed acceptable based on economic, safety, and reliability considerations.
Ampere	The unit of current flowing in a conductor.
Kiloampere (kA)	1,000 Amperes
Bundled	Two wires, 18 inches apart.
Bus	Conductors that serve as a common connection for two or more circuits.
Conductor	The part of the transmission line (the wire) that carries the current.
Congestion Management	Congestion management is a scheduling protocol, which provides that dispatched generation and transmission loading (imports) would not violate criteria.
Emergency Overload	See Single Contingency. This is also called an L-1.
Kcmil or kcm	Thousand circular mil. A unit of the conductor's cross sectional area, when divided by 1,273, the area in square inches is obtained.
Kilovolt (kV)	A unit of potential difference, or voltage, between two conductors of a circuit, or between a conductor and the ground. 1,000 Volts.
Loop	An electrical cul de sac. A transmission configuration that interrupts an existing circuit, diverts it to another connection and returns it back to the interrupted circuit, thus forming a loop or cul de sac.
Megavar	One megavolt ampere reactive.

Megavars	Megavolt Ampere-Reactive. One million Volt-Ampere-Reactive. Reactive power is generally associated with the reactive nature of motor loads that must be fed by generation units in the system.
Megavolt ampere (MVA)	A unit of apparent power, equals the product of the line voltage in kilovolts, current in amperes, the square root of 3, and divided by 1000.
Megawatt (MW)	A unit of power equivalent to 1,341 horsepower.
Normal Operation/ Normal Overload	When all customers receive the power they are entitled to without interruption and at steady voltage, and no element of the transmission system is loaded beyond its continuous rating.
N-1 Condition	See Single Contingency.
Outlet	Transmission facilities (circuit, transformer, circuit breaker, etc.) linking generation facilities to the main grid.
Power Flow Analysis	A power flow analysis is a forward looking computer simulation of essentially all generation and transmission system facilities that identifies overloaded circuits, transformers and other equipment and system voltage levels.
Reactive Power	Reactive power is generally associated with the reactive nature of inductive loads like motor loads that must be fed by generation units in the system. An adequate supply of reactive power is required to maintain voltage levels in the system.
Remedial Action Scheme (RAS)	A remedial action scheme is an automatic control provision, which, for instance, would trip a selected generating unit upon a circuit overload.
SF6	Sulfur hexafluoride is an insulating medium.
Single Contingency	Also known as emergency or N-1 condition, occurs when one major transmission element (circuit, transformer, circuit breaker, etc.) or one generator is out of service.
Solid dielectric cable	Copper or aluminum conductors that are insulated by solid polyethylene type insulation and covered by a metallic shield and outer polyethylene jacket.

Switchyard	A power plant switchyard (switchyard) is an integral part of a power lant and is used as an outlet for one or more electric generators.
Thermal rating	See ampacity.
TSE	Transmission System Engineering.
TRV	Transient Recovery Voltage
Tap	A transmission configuration creating an interconnection through a sort single circuit to a small or medium sized load or a generator. The new single circuit line is inserted into an existing circuit by utilizing breakers at existing terminals of the circuit, rather than installing breakers at the interconnection in a new switchyard.
Undercrossing	A transmission configuration where a transmission line crosses below the conductors of another transmission line, generally at 90 degrees.
Underbuild	A transmission or distribution configuration where a transmission or distribution circuit is attached to a transmission tower or pole below (under) the principle transmission line conductors.